

1.2 Quantity Distances Shorter and Safer

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INTRODUCTION

The British military quantity-distances are closely related to those agreed by NATO and over the last 4 years the Science, Explosives & Testing branch of the Naval Support Command has been asked to advise on the safety of over 400 potential explosion sites which do not accord with the quantity-distances advised by the UK Explosives and Storage Transport Committee (ESTC).

Based on some of the experience gained in giving this advice, this paper reports how quantity-distances for some Hazard Division 1.2 explosives can be shorter without compromising safety.

BACKGROUND

UK HD 1.2 Quantity-Distances are based on fragment throw and are set at distances where the concentration of lethal fragments which accumulates over the duration of an event is deemed tolerable. [1 x 80J frag/56sq m]. Figure 1 shows that they are almost as greedy of space as those for HD 1.1.

Both HD 1.1 and 1.2 distances have minimum distances to cope with building debris and unexploded ordnance. HD 1.1 diverges as blast becomes the predominant effect.

HD 1.2 quantity-distances distinguish between big and small items of HE ammunition as the difference in detonating energy at fragment launch means that fragment kinetic energies differ. The HD 1.2 quantity-distances become asymptotic due to the limit of fragment throw.

Joint research and tests by the US Navy and the UK ESTC is reported elsewhere in this seminar. Their work re-assesses lethal primary fragment throws from fires of stacks of Rounds 105mm Pack Howitzer HE representing credible worst case events. A fair proportion of HE shell in a test survived. Almost all explosions were cook-offs creating sub-sonic fragments. There were very few isolated detonations.

The joint test program is progressing. As the ammunition involved could detonate we expect that the existing design for heavy barricades will still be needed but as the arising of lethal fragments is less than that assumed for the current basis for UK HD 1.2 quantity-distances. We can therefore look forward to applying shorter distances in the future.

Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE AUG 1994		2. REPORT TYPE		3. DATES COVERED 00-00-1994 to 00-00-1994	
4. TITLE AND SUBTITLE 1.2 Quantity Distances Shorter and Safer				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Ministry of Defence,MOD(Navy), DES(OAE)/CINO,,Ensleigh,Bath BA1 5AB, UK.,				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES See also ADM000767. Proceedings of the Twenty-Sixth DoD Explosives Safety Seminar Held in Miami, FL on 16-18 August 1994.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 8	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Meantime the Royal Navy had a problem which couldn't wait the outcome of the joint test program. There were a number of HD 1.2 process buildings to be sited in a very compact depot.

In order to accomodate them using existing quantity distances heavy barricades and concrete roofs would be needed which would almost double construction costs.

However knowing that nearly all HD 1.2 accidental explosions would be cook-offs it would be possible to minimise costs by discovering when it was certain that all explosions would be low order as stopping sub-sonic fragments is cheaper.

Another problem was that even if low order explosions were certain there wasn't a valid model which predicts design fragment mass and velocity from cook-offs so lighter and cheaper barricades could not be specified, confident that they were also cost effective.

Therefore some HD 1.2 heavy cased HE ammunition was tested. Single projectiles were deliberately cooked-off in a fragment arena.

Figure 2 shows the general arrangement for the cook-off arena.

The projectile is a Shell 105mm Pack Howitzer HE, an old design with a very heavy case. It is laid on its side because that's how it's stored in British service. Heat is applied using a high temperature camping gas burner. Rupture of a wire wound tightly around the shell signals the time of burst. The arena comprises electronic screens which witness fragment strike. Behind them are hardboard sheets made up to 60 centimetres thick and backed by steel plate.

Over a number of tests the flame from the burner was applied to the shell base, the body, the ogive and the fuze. The shell usually cooked-off giving rise to a few, subsonic, large fragments as shown in figure 3.

The fragments hardly penetrated the screens with some heavy fragments rebounding off the screens as shown in figure 4.

Generally the fragments were numbered in tens, their velocities were 90-230 metres per second and weights were 0.01-680gm. Often lumps of unexploded HE were thrown out.

However there was a detonation when flame was applied to the fuze. As the fuze's detonators were not in line, that is the fuze was unarmed, it is assumed that the transfer of heat along the fuze body caused its fully confined exploder to detonate. Well over 1000 steel fragments were recovered as shown in figure 5. Some others were not caught by the arena.

This is a typical recovery from one part of the arena after a detonation. The fragments can be seen to be small and jagged. Their velocities were 2,600-3,000 metres per second and some fully penetrated the screen hardboard backing and were stopped by the steel plate. Weights ranged from less than 0.01g to 290g with approximately 92% weighing less than 0.5gm.

The test was repeated with Bomb 81mm Mortar HE. These are a modern design with thinner casing to optimize the production of lethal fragments when detonated as designed. However there were no detonations in our test and all events were milder than those with the 105mm Shell. When heat was applied to the fuze the mildest event of all occurred. This is in marked contrast to the situation with the shell.

For those interested in insensitive munitions and weapon effect mitigation technology, the mild events occurred because the mortar bomb fuzes always popped out under pressure. The design and machining of the screw threads on the fuze and in the fuze well were much less robust than in the older design of shell. With the bomb the screw threads stripped very easily thereby avoiding pressure build-up inducing a detonation.

After the tests there was confidence that cook-off fragment barricades could be specified cost effectively.

Interestingly a survey of the Navy's HD 1.2 ammunition holdings showed that all were filled with pyrotechnic mixes, so 100% low order explosions were predicted.

For the new process buildings the cheapest barricade was to use single wythe walls built from industry standard concrete blocks laid flat despite this exceeding barricade specification. There was no need for heavy roofs as the amount of ammunition per building was small and so the concentration of lobbed lethal fragments that could escape through the roof was easily tolerable by ESTC standards. The overall saving in building costs was 45%.

Implications for HD 1.2 Quantity-Distances.

If fragments can be satisfactorily controlled with barricades and heavy roofs then magazines and process buildings holding HD 1.2 can be sited as if they are holding HD 1.4 explosives.

This does not mean that HD 1.2 should be reclassified as HD 1.4. It still behaves in a fire as HD 1.2. It throws out hazardous fragments and this information is needed by fire-fighters, especially for fires during transportation.

Non-detonating HD 1.2 would attract light and cheap barricades.

Non-HE HD 1.2 is non-detonating.

At approximately 2 tonnes explosive weight the escape of lobbed lethal fragments could become intolerable; heavy roofs would be needed.

Given the right barricades and roofs it would be possible to set Non-HE quantity-distances to the public at a fixed distance of 25 metres, that is, like HD 1.4 explosives.

HE HD 1.2 stored in Igloos should also only need 25 metres.

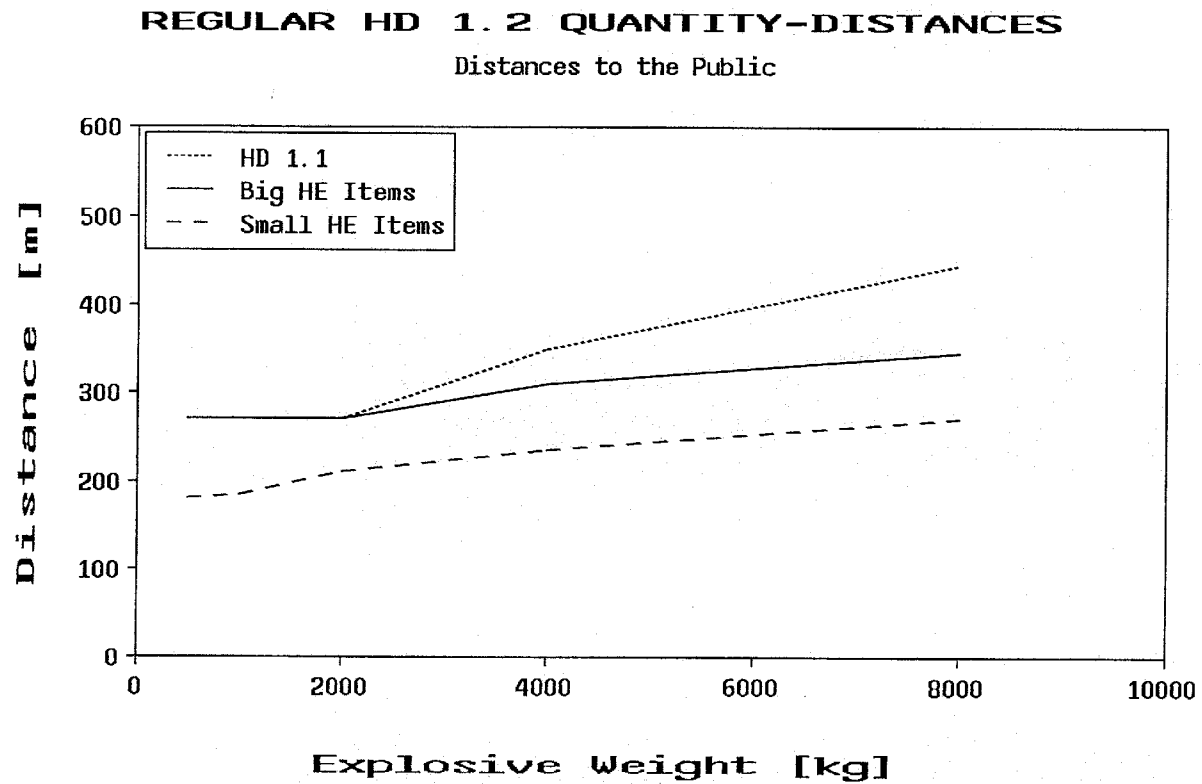


FIGURE 1. REGULAR HD 1.2 QUANTITY-DISTANCES

FIGURE 2.

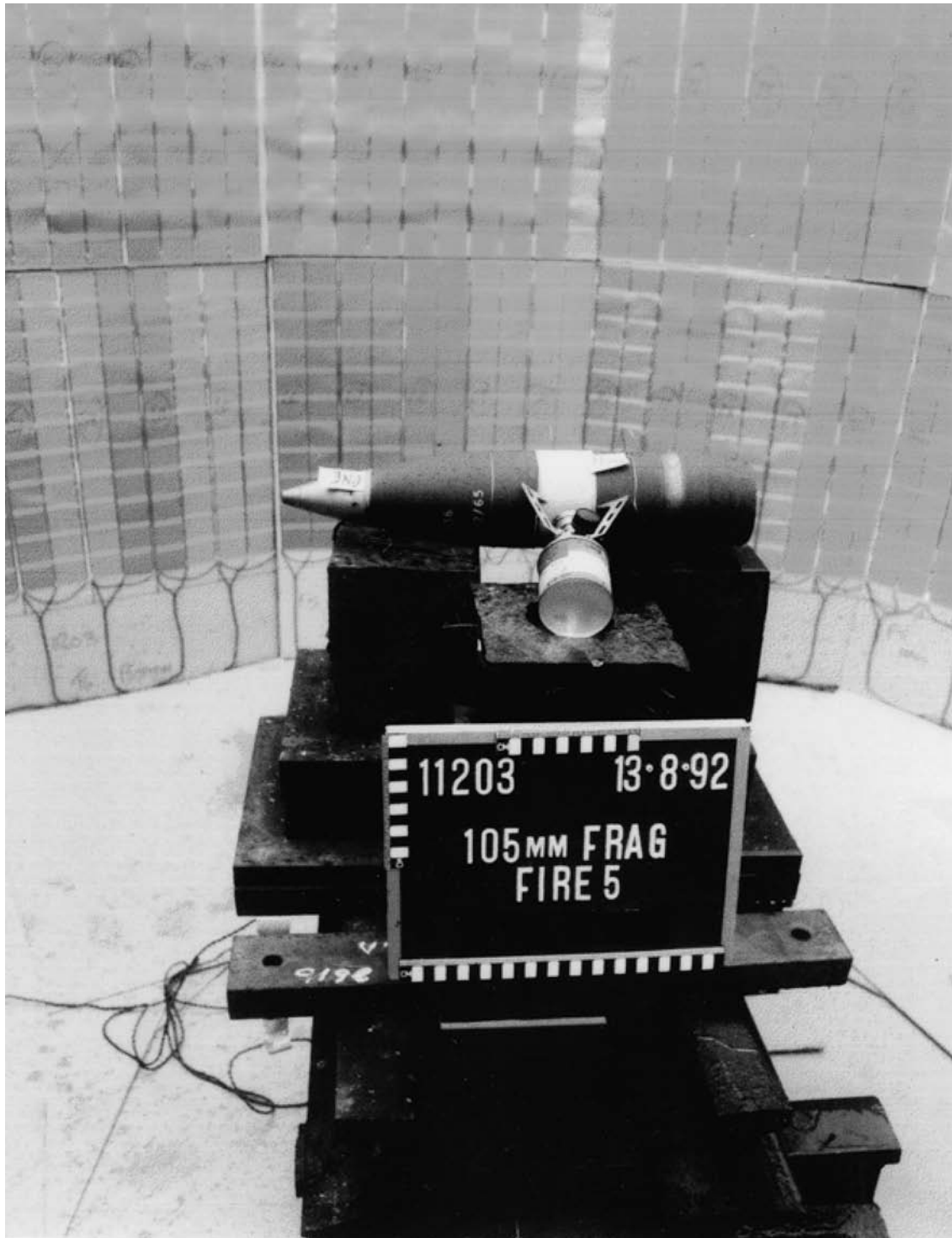


FIGURE 3.

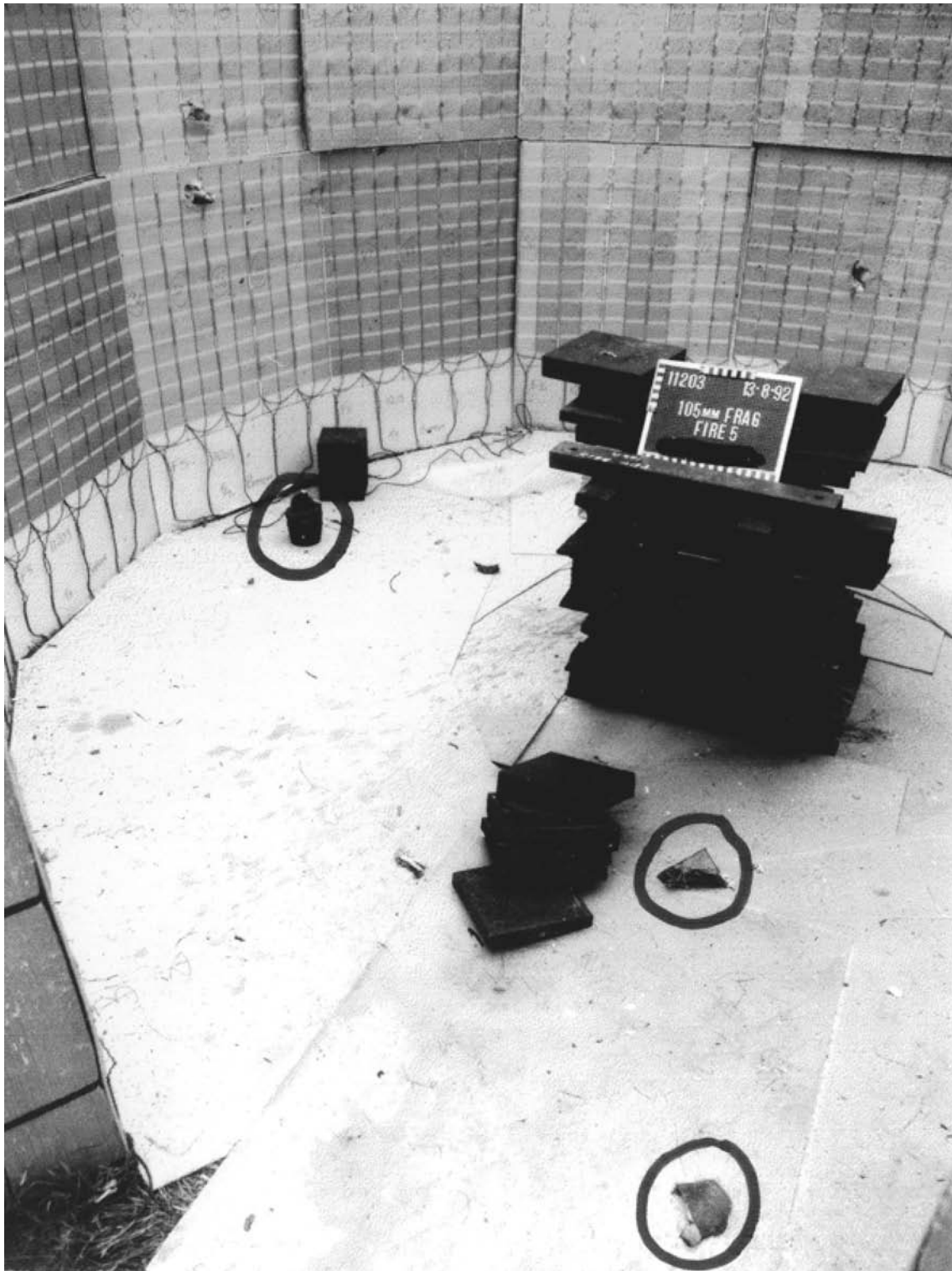


FIGURE 4.

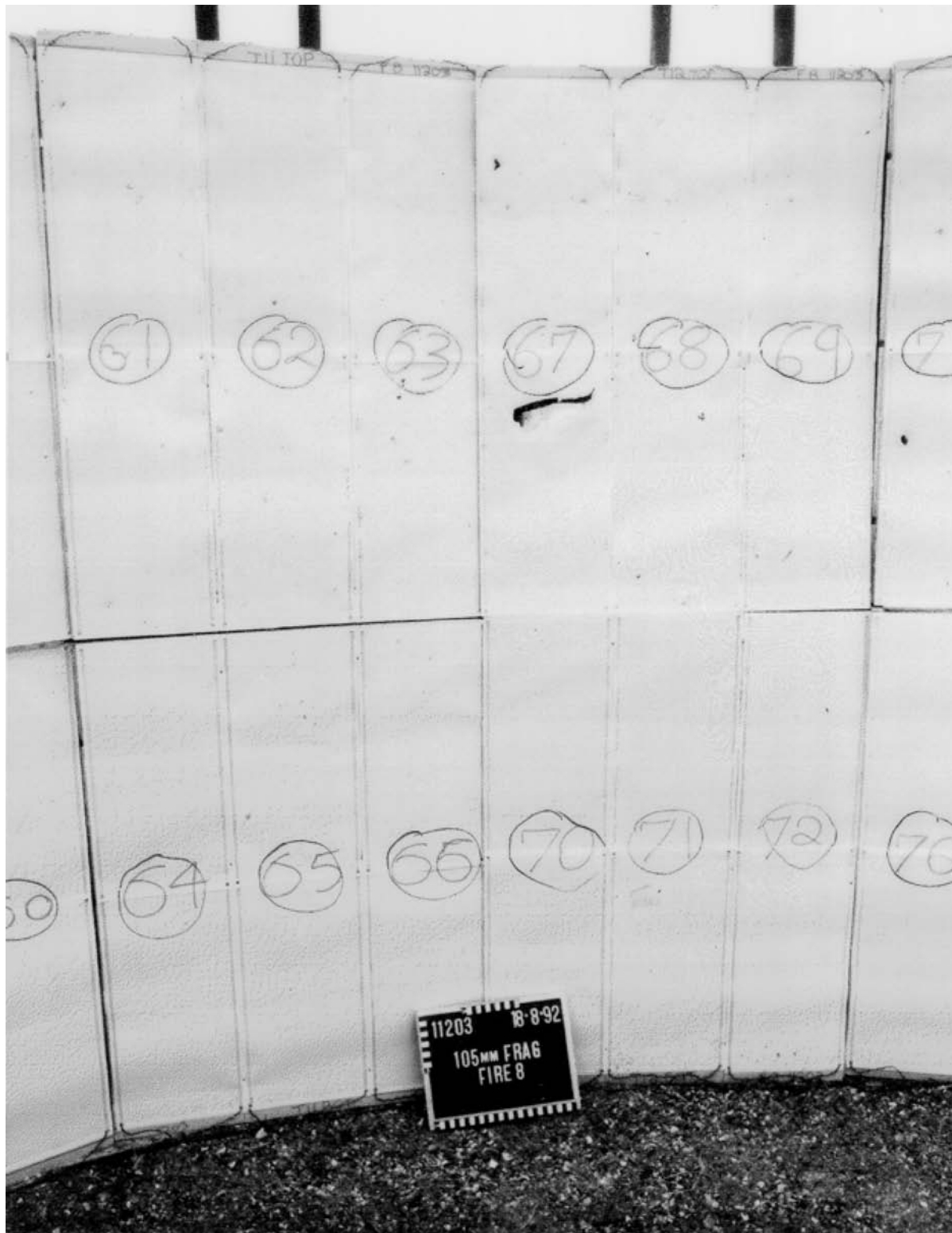


FIGURE 5.

